DEC STD 176-2 Printed-Wiring Board Product Safety Criteria

DOCUMENT IDENTIFIER: A-DS-EL00176-02-0000 Rev C, 17-Jun-1991

ABSTRACT: This manufacturing standard specifies product safety criteria for rigid printed-wiring boards that have been fabricated or purchased for Digital Equipment Corporation.

APPLICABILITY: Whether fabricated in Digital manufacturing facilities or purchased from qualified suppliers, all printed-wiring boards shall meet or exceed all applicable specifications found in this standard, as modified only by related Digital drawings and specifications.

STATUS: APPROVED 17-Jun-1991; use VTX SMC for current status.

This document is confidential and proprietary, and is the property of Digital Equipment Corporation. It is an unpublished work protected under the Federal copyright laws.

© Digital Equipment Corporation. 1991. All rights reserved.

DEC STD 176-2 Printed-Wiring Board Product Safety Criteria

DOCUMENT IDENTIFIER: A-DS-EL00176-02-0000 Rev C, 17-Jun-1991

REVISION HISTORY:	Rev A,	09-Dec-1986	
	Rev B,	22-Sep-1988	ECO Number CT001
	Rev C,	17-Jun-1991	ECO Number CTS02

Document Management Category:	Board Manufacture (MB)
Responsible Department:	Corporate Printed-Wiring Board
Responsible Person:	Gerald G. Gagnon
SMC Writer:	Eric Falkof

APPROVAL: This document has been reviewed and recommended for approval by the General Review group for its category and the DEC STD 176 Advisory Committee.

Gerry Gagnon - Corporate Printed-Wiring Board Group

Eric Williams - Standards Process Manager

Direct requests for further information to:

Gerry Gagnon
Use $ VTX ELF for the latest location information.

Use VTX SMC to order copies of this document from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

CONTENTS

1 INTRODUCTION 1
1.1 PURPOSE 1
1.2 SCOPE 1
1.3 RESPONSIBILITIES 1
1.3.1 External PWB Suppliers 1
1.3.2 PWB Standards Committee 2

2 PRODUCT SAFETY REQUIREMENTS 2
2.1 PRODUCT SAFETY REQUIREMENTS—INTERNALLY FABRICATED PWBs 2
2.1.1 Product Design and End-Use Requirements 3
2.1.2 PWB Process Requirements 5
2.1.3 PWB Material Requirements 6
2.1.3.1 Laminate and Prepreg Materials 6
2.1.3.2 Soldermask Permanent Coating 7
2.1.3.3 Copper Foils 8
2.1.4 Product Safety Markings 8
2.1.5 Specific Responsibilities 10
2.2 PRODUCT SAFETY REQUIREMENTS—EXTERNALLY FABRICATED PWBs . . . 11
2.2.1 Product Design and End-Use Requirements 11
2.2.2 PWB Process Requirements 12
2.2.3 PWB Material Requirements 12
2.2.4 Product Safety Markings 12
2.2.5 Specific Responsibilities 12

Appendix A FLAMMABILITY TESTING 13

Appendix B REFERENCED DOCUMENTS 17

B.1 EL-Class Digital Documents 17

B.2 Other Documents 17

B.3 Ordering Information 17

Appendix C RELATED DOCUMENTS 19

C.1 EL-Class Digital Documents 19

FIGURES

1 UL PWB Recognition Parameters 4
2 Required Block Dimensions of UL Frame and Copyright and Mask Works Protection Markings 9

1 INTRODUCTION

As stated in *DEC STD 119-0 Digital Product Safety—Introduction and General Requirements,* it is the policy of Digital Equipment Corporation to design and manufacture safe and reliable products. Most of DEC STD 119 product safety criteria is derived from UL (USA), CSA (Canada), and IEC (International) product safety standards.

Consistent with the overall requirements of DEC STD 119, the product safety design requirements for printed-wiring boards are incorporated within Digital design standards. Designing to Digital design standards results in Digital's PWB designs meeting the applicable product safety standards.

1.1 PURPOSE

This manufacturing standard defines in further detail, specific product safety criteria that must be met by PWB fabricators. Fabricating to the requirements of this document results in Digital PWBs meeting all applicable product safety standards from design through finish product level.

1.2 SCOPE

The requirements of this manufacturing standard apply to all rigid printed-wiring boards fabricated by or purchased for Digital Equipment Corporation.

1.3 RESPONSIBILITIES

The following groups are responsible for an understanding of the requirements set by this standard. They are also responsible for compliance with the standard and providing information to keep the standard up to date.

- Groups associated with producibility and design for manufacturability.
- PWB plant product safety personnel.
- Module assembly process product safety personnel.
- PWB plant personnel that specify and purchase raw materials for PWBs.
- PWB plant personnel involved with the process of fabricating PWBs (Production, Engineering, Quality Control/Assurance).
- Printed circuit board (modules) assembly process personnel (Production, Engineering, Quality Control/Assurance) involved with the process of fabricating modules, and its affects on the PWB recognition.
- Groups involved with the external sourcing of Digital PWB products.

1.3.1 External PWB Suppliers

All external PWB suppliers under contract to produce PWBs for Digital are responsible for an understanding of the requirements set by this standard. They are also responsible for compliance with the standard and providing information to keep the standard up to date.

1.3.2 PWB Standards Committee

Refer to EL-SM176-00 *Printed-Wiring Board Manual*, Table 2 for a list of committee members.

2 PRODUCT SAFETY REQUIREMENTS

Digital design standards establish the minimum safety requirements that are designed into Digital PWBs. The minimum safety requirements for all PWBs are derived from Underwriter's Laboratories (UL) component recognition requirements per *UL 796 Standard for Safety—Printed-Wiring Boards, and UL 94 Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.*

All Digital PWBs must have UL component recognition. Component recognition indicates that the PWB fabricator has successfully completed the following criteria:

1. Initiated a recognition program for printed-wiring components
2. Provided UL with the location(s) of the specific PWB manufacturing plant(s) and plant contact(s).
3. Provided UL with a description of the design parameters and product features required by UL 796 for the range of PWB designs to be recognized.
4. Provided UL with a description of the manufacturing processes required by UL 796 that will be used to produce recognized PWBs.
5. Provided UL with a listing of all material suppliers and the specific laminate, prepreg, and soldermask materials used in the fabrication of recognized PWBs.
6. Provided UL with a description of the on-circuit markings that the fabricator desires UL to use in order to identify recognized product.
7. Provided UL with samples fabricated per items (1) through (6), and successfully completed testing at UL per UL 796.
8. Maintain recognition status through the UL follow-up Services Audit Program.

The specific details of PWB designs, manufacturing processes, materials, and markings employed in the fabrication of recognized product must be closely monitored by all responsible parties to assure that any changes do not adversely affect the recognition of the PWB.

2.1 PRODUCT SAFETY REQUIREMENTS—INTERNALLY FABRICATED PWBs

All internally fabricated PWBs are UL recognized based on the design practice, processes, materials, and markings currently used as of the date of this document. Digital design standards define the required design pattern limits. Design-induced changes in circuit patterns and markings that affect UL recognition will be flagged as violations to Digital design standards. Manufacturing-induced changes in design, processes, materials, and markings will be flagged as violations to this document.

2.1.1 Product Design and End-Use Requirements

Per UL 796, internally fabricated PWBs are recognized by UL as meeting applicable product safety testing for the following design and end-use characteristics. Descriptions are provided here. The actual values are summarized in Figure 1:

Maximum operating temperature – The maximum continuous use temperature that the PWB may be exposed to in its intended application under normal operating conditions.

Maximum solder limit temperature – Unless specifically designed for hand soldering, each PWB construction is assigned a maximum temperature and dwell time. The tabulated values are the maximum temperature and time at the maximum temperature to which PWBs may be subjected during *mass soldering* of components. Recognition is based on meeting both temperature and time conditions. Assembly rework is not considered by UL as part of UL recognition.

Minimum conductor width – The minimum width of any conductor spaced more than 0.015 inch (0.38 mm) from the circuit edge.

Number of clad sides – Indicates whether fabricated circuits have a conductive pattern on one (single-sided) or both (double-sided) sides.

Minimum cladding conductor thickness – The minimum metallic cladding (foil) thickness of the conductor exclusive of plating.

Maximum conductor thickness – The maximum thickness of copper conductors. For outer layers, the maximum thickness includes all plating. For inner layers, the maximum thickness is generally the base foil thickness. However, in the case where inner layers are plated, the maximum thickness must also include all plating.

Maximum area diameter – The maximum unpierced conductor (or plane) area of a PWB judged by the diameter of the largest circle that can be inscribed within the pattern.

Minimum base material thickness – The minimum laminate-to-laminate thickness of the finished PWB.

UL-94 flammability rating – Rating applied to completely processed PWB or minimum base material thickness with soldermask coating. Refer to Appendix A.

Figure 1: UL PWB Recognition Parameters

	SINGLE– and DOUBLE–SIDED PWBs				MULTILAYER PWBs		
	TYPE 1	TYPE 5	TYPE 7	TYPE 9	TYPE 2	TYPE 4	TYPE 6
MAXIMUM OPERATING TEMP. (CELSIUS)	130°	105°	105°	105°	105°	105°	105°
MINIMUM FLAMMABILITY RATING	94V–1	94V–1	94V–1	94V–1	94V–1	94V–1	94V–1
MAXIMUM SOLDER LIMIT TEMP. CELSIUS AND DWELL TIME *	268° FOR 5 SEC.	260° FOR 10 SEC.	260° FOR 10 SEC.	260° FOR 10 SEC.	260° FOR 10 SEC.	260° FOR 10 SEC.	260° FOR 10 SEC.
NUMBER OF CLAD SIDES	SS/DS	SS/DS	SS/DS	SS/DS	SS/DS	SS/DS	SS/DS
MINIMUM CLAD (FOIL) CONDUCTOR THICKNESS * *	0.00065 inch (0.01651mm)	0.00065 inch (0.01651mm)	0.00065 inch (0.01651mm)	0.00049 inch (0.01245mm)	0.00065 inch (0.01651mm)	0.00065 inch (0.01651mm)	0.00049 inch (0.01245mm)
MAXIMUM CONDUCTOR THICKNESS INCLUSIVE OF PLATING * * *	O/L: 0.0046 inch (0.1168 mm) I/L: N/A	O/L: 0.0046 inch (0.1168 mm) I/L: N/A	O/L: 0.0046 inch (0.1168 mm) I/L: N/A	O/L: 0.0046 inch (0.1168 mm) I/L: N/A	O/L: 0.0046 inch (0.1168 mm) I/L: 0.0096 inch (0.24348mm)	O/L: 0.0046 inch (0.1168 mm) I/L: 0.0039 inch (0.0990 mm)	O/L: 0.0046 inch (0.1168 mm) I/L: 0.0039 inch (0.0990 mm)
MINIMUM CONDUCTOR WIDTH	0.004 inch (0.102 mm)	0.004 inch (0.102 mm)	0.004 inch (0.102 mm)	0.003 inch (0.076 mm)	0.004 inch (0.102 mm)	0.004 inch (0.102 mm)	0.003 inch (0.076 mm)
MAXIMUM AREA DIAMETER	2.0 inches (50.8 mm)	2.0 inches (50.8 mm)	2.0 inches (50.8 mm)	5.0 inches (127.0 mm)	2.0 inches (50.8 mm)	2.0 inches (50.8 mm)	5.0 inches (127.0 mm)
MINIMUM BASE MATERIAL THICKNESS	0.050 inch (1.27 mm)	0.038 inch (0.97 mm)	0.050 inch (1.27 mm)	0.050 inch (1.27 mm)	0.038 inch (0.97 mm)	0.050 inch (1.27 mm)	0.050 inch (1.27 mm)
PWB MATERIAL SPECIFIED	ANSI grade FR–4	ANSI grade FR–4	**** Polyimide	**** BT	ANSI grade FR–4 (All Layers)	**** Polyimide All Layers	**** BT All Layers

Notes for Figure 1:

* Maximum solder limit temperature and dwell time is an end-use parameter that is generally not controllable by the PWB fabricator since *mass soldering* of components occurs at the Module Assembly Process. Therefore, this parameter must be monitored and controlled by all pertinent Module Assembly Process groups in order to assure that the UL recognition of internally fabricated PWBs is maintained.)

* * This is the minimum foil thickness for outer layers.

* * * O/L = Outer Layer, I/L = Inner Layer.

* * * * As the release date of this document, Digital internal fabricators are recognized to produce PWBs from polyimide and bismaleimide trizine (BT) materials. These materials

are not recognized by UL at this time as a generic material grade, Digital's recognition for PWBs made from these materials is limited to a specific group of laminate/soldermask materials and laminate/soldermask material suppliers. For internal sources of supply should contact James Apruzzi; see VTX ELF for location information.

NOTE

Digital is recognized by UL to produce printed-wiring boards to these parameters. Exceeding any of these parameters may adversely affect UL recognition of the PWB. Consult Product Safety when applicable.

2.1.2 PWB Process Requirements

UL requires the PWB fabricator to describe certain processing steps involved with the formation of conductors, plating finishes, laminations, and permanent protective coatings for each unique type of recognized product.

All process steps meeting the following criteria must be described in the Manufacturing Process section of the PWB fabricator's UL file:

1. The greater of PWB surface temperature or UL maximum operating temperature of the laminate. See Figure 1.
2. Where acid and alkali concentrations exceed 10%.
3. A change in etchant from the surface conductor pattern from acidic/alkaline to chromic/sulfuric. Any etchant may be used to form inner-layer conductive patterns.
4. Addition of plated-through hole (or multiple levels of plated-through hole) steps to an existing process.
5. Process steps that can adversely affect the bond strength of surface conductors, resistance of the laminate (lamination) to delamination or blistering, and flammability rating or the finished PWB.

Since UL recognition is based on the use of a stated process, additional process steps meeting the above criteria cannot be used on recognized product unless listed in the Manufacturing Process section of the PWB fabricator's UL file.

Any of the processing steps listed in the Manufacturing Process section of the PWB fabricator's UL file may be omitted at the fabricator's option to produce a recognized product with fewer finish features.

The addition of process steps meeting the above criteria to the fabricator's recognized manufacturing process generally will involve producing samples (per the listed design and end-use parameters) according to the desired *new* process and submitting to UL for recognition testing.

As of the date of this document, Digital internally produces PWBs by the following processes:

1. Single-sided and double-sided patterns on PWBs with the following finishes:
   a. Conductors with bare copper or reflowed tin/lead finish.
   b. Plated-through holes with reflowed tin/lead or solder-coated finish.
   c. Contact fingers with gold/nickel or reflowed tin/lead or solder-coated finish.

d. Soldermask permanent coating.

2. Single-sided and double-sided patterns on multilayer and multisignal layer PWBs with the following finish features:

   a. Conductors with bare copper, plated and reflowed tin/lead, or solder -coated finishes.

   b. Plated-through holes with plated and reflowed tin/lead or soldercoated finishes.

   c. Contact fingers with gold/nickel, plated and reflowed tin/lead, or solder-coated finishes.

   d. Soldermask permanent coating.

   e. Buried via plated-through holes (on type 6 PWBs only).

NOTE

Digital is not currently UL recognized to internally produce *blind* via interconnect structures due to additional lamination and plated-through hole process steps that are involved. Digital is recognized to internally produce *buried* via interconnect structures only from materials and processes defined for type 6 PWBs only.

2.1.3 PWB Material Requirements

As a minimum, all laminate raw material used in recognized PWBs shall be previously investigated, tested, and listed by UL in the laminate materials section of the UL recognized component directory. It is preferred that the laminate raw material be recognized by UL as a generic ANSI grade as part of the listing in the recognized component directory. All soldermask materials shall also be listed in the permanent coatings section of the UL Recognized Directory.

UL requires that all PWB base materials affecting electrical, mechanical, and flammability properties of the finished product be investigated and listed in the Materials section of the PWB fabricator's UL file. For PWBs, the materials of interest to UL are laminate, prepreg, foil, and soldermask.

2.1.3.1 Laminate and Prepreg Materials

For PWB recognition, UL will generally require the PWB fabricator to submit test samples for each different laminate/prepreg manufacturer and for each different ANSI *grade* of material, (for example, FR-4, FR-5, and so on). Upon successful completion of testing, UL will list each ANSI grade laminate and prepreg manufacturer in the materials section of the PWB fabricator's UL file. UL recognition from a material perspective, is based on the use of the listed materials and vendors. No additions, changes, or substitutions to the listed materials and vendors are allowed for recognized PWBs unless investigated, tested, or otherwise approved by UL.

In many instances, laminate/prepreg manufacturers have had their material investigated, ANSI grade assigned, tested, and recognized by UL across a broad spectrum of design and end-use parameters (Underwriter's Laboratories Metal Clad Industrial Laminates Program). For these recognized ANSI material grades only, PWB fabricators can add additional materials meeting the UL requirements of the recognized ANSI grade to their UL file with minimal testing if UL investigation shows a favorable comparison of the recognized material parameters to those desired by the PWB fabricator.

Laminate and prepreg materials are added to the PWB fabricator's UL file Material section as *pure vendor packages*, for example, laminate/prepreg of the same grade and manufacturer comprise the complete base material for the finished recognized PWB. The advantages to the PWB fabricator of using laminate/prepreg materials from manufacturers that are recognized under the UL Metal Clad Industrial Laminates Program (MCIL) are:

a. Addition of laminate/prepreg materials with minimal testing, which could save cost and avoid lengthy periods of time.

b. Whenever UL recognition testing becomes necessary for the PWB fabricator due to desired changes to the PWB fabricator's UL file, the cost and length of time can also be dramatically reduced.

The usage of laminate materials that are not recognized as ANSI grade shall be UL listed as a minimum. For usage of laminate materials that have not been investigated and recognized under the UL MCIL may require complete testing by UL before the materials can be added to the PWB fabricator's UL file.

The usage of listed but not ANSI grades of material as well as *mixed vendor* or *mixed grade* material *packages*, for example:

a. Laminate from vendor A and the same grade of prepreg from vendor B.

b. Laminate from vendor A and a different grade of prepreg from vendor A or vendor B.

All require investigation and testing by UL (regardless of the UL MCIL status of either vendor) before the materials can be added to the PWB fabricator's UL file.

The disadvantages of using listed but not ANSI grades of material as well as *mixed vendor* or *mixed grade* materials *packages* are:

a. Addition of materials to the PWB fabricator's UL file can be lengthy and costly.

b. Whenever UL recognition testing becomes necessary for the PWB fabricator due to desired changes to the PWB fabricators' UL file, the cost and length of time can be prohibitive.

As of the release date of this document, internally fabricated PWBs are UL recognized for ANSI grade materials in *pure vendor grade packages* only.

2.1.3.2 Soldermask Permanent Coating

UL requires that all permanent protective coatings applied to recognized PWBs be investigated and tested with respect to flammability per UL 94. Permanent ink applied as nomenclature or other markings is not considered to be a protective coating by UL. Flux and antioxidant are not considered to be protective coatings.

Soldermask and *conformal coatings* are considered to be permanent protective coatings. Since Digital does not use *conformal coatings*, this document will only consider soldermask permanent coatings.

UL will generally require testing of soldermask applied to recognized base materials according to the flammability rating desired by the PWB fabricator. Upon successful completion of testing, the soldermask material, supplier, and application temperature and/or time are listed in the PWB fabricator's UL file.

As in the case of laminate/prepreg manufacturers, certain soldermask manufacturers have undergone recognition testing per the UL Coatings Program for variations in soldermask and base material thicknesses across a broad spectrum of potential PWB end-uses.

Whenever flammability testing is performed for internal investigation or simulation of tests to be performed at UL, the testing and data recording shall be per Appendix A of this document.

Flammability testing can be waived by UL only for approved soldermasks if:

a. The PWB fabricator is UL recognized with a flammability rating on the same grade and thickness of base material as the rating of the desired soldermask.

b. The PWB fabricator's recognition criteria do not exceed those of the desired soldermask.

c. The flammability rating cannot be higher than the established flammability rating for the PWB fabricator.

d. The flammability rating cannot be higher than the established flammability rating for the uncoated base laminate material of the minimum laminate thickness for the PWB fabricator.

e. The PWB fabricator must use the coating and curing procedure specified by the soldermask coating manufacturer.

The advantages of using soldermask materials and suppliers recognized under the UL Coatings Program are the same as for using UL MCIL approved laminates/prepregs: avoidance of lengthy delays and reduced UL testing costs.

As of the date of this document, all soldermasks used on internally fabricated PWBs shall have a flammability rating of 94V-1 minimum when coated on minimum laminate thickness 94V-1 base materials, specified in Figure 1.

2.1.3.3 Copper Foils

The only aspects of copper foils that are of interest to UL pertain to the minimum outer-layer foil thickness and the maximum inner-layer foil thickness recognized for the PWB fabricator.

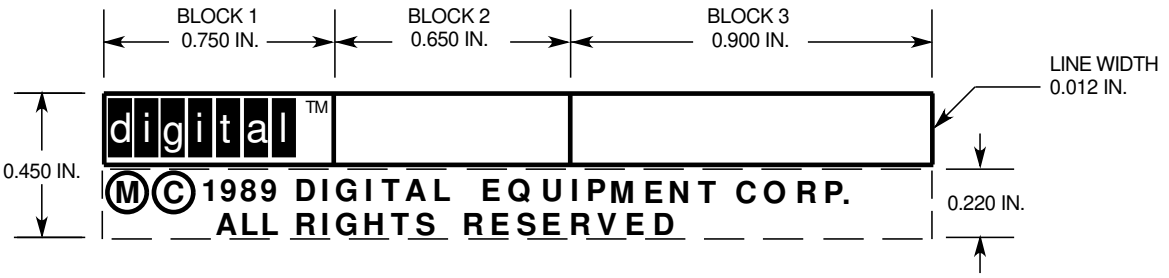
2.1.4 Product Safety Markings

It is a UL requirement that each printed-wiring board must be permanently marked in etch or printing with authorized symbols by which the organization responsible for the product may be identified. Additional authorized symbols indicating that the printed-wiring board has been recognized and assigned a flammability rating by UL may appear on the board.

In addition, if printed-wiring boards are produced at more than one factory location, each board shall have a distinctive marking which will identify it as the product of a particular factory.

Consistent with DEC STD 119 and Digital design standard requirements, the product safety markings for all Digital PWBs are to be contained within the appropriate product safety frame blocks according to the location, dimensions, and format provided in the product data. For the purpose of clarity, a description of the product safety frame blocks is provided in Figure 2.

Figure 2: Required Block Dimensions of UL Frame and Copyright and Mask Works Protection Markings



NOTE

The design requirement for PWB power level markings (that is HPWR and LPWR) has been eliminated. This results in an arrangement of the UL block information as follows.

Block 1: Approved registered trademark version of DIGITAL logo applied by design.

Block 2: UL recognition markings applied by the PWB fabricator exactly as the markings appear in the UL recognized component directory for the applicable PWB supplier. For internal PWBs the UL marking is a combination of shortened plant code (GS and/or SG) and the UL PWB type code from Figure 1, for example, GS-7, SG-7.

Block 3: The Julian date code applied by the PWB fabricator used for traceability. The Julian date code consists of the five-letter format DDDYY, where:

DDD = The Julian date
YY = The last two digits of the year

The entire product safety frame and Block 1 data are entered by the design site in the design data base. The data for Blocks 2 and 3 are to be supplied by the PWB manufacturing site.

As of the date of this document, markings applied in accordance with the above comply with all Digital and UL product safety marking requirements.

Exceptions:

The requirement for UL recognition markings is not waiverable. There may be situations such as designs built to older revisions of Digital design standards or designs that are physically too small for the product safety blocks.

With respect to designs produced to older revisions of design standards, every effort must be made by manufacturing in conjunction with producibility to keep designs consistent with current product safety marking requirements.

Where this is proven to be impractical and for designs where finished circuit size is too small to meet Digital design standards marking requirements, the following markings are the minimum that shall appear:

a. The full 50-class part number and revision.

b. The product safety frame outline itself does not have to appear, as it is intended to provide the location for the markings.

c. The Digital logo must appear on all circuits, however only one logo is required if one is not provided in the product safety frame.

d. The factory identification and process code (AP-1, GS-2, and so on) must appear on all circuits.

e. The Julian date code must appear on all circuits.

Items c and d must appear in close proximity on the same side (side 1 preferably) of the circuit. The size of the lettering used can be as small as current imaging and etching processes can resolve. Markings can be screened or stamped on each circuit with nonconductive permanent ink. Producibility must be consulted for placement of markings.

In addition to the requirements for the product safety markings themselves, the markings and process(es) for applying the markings shall:

a. Be compatible with board materials and components.

b. Have no measurable effect on board performance.

c. Be legible after the performance of all PWB tests specified in other sections of EL-SM176-00 *Printed-Wiring Board Manual* and other applicable standards.

d. Be legible after all Digital Module Assembly processes.

2.1.5 Specific Responsibilities

The ability to determine and maintain compliance with UL (and other) product safety requirements requires knowledge of the specific details contained within Digital's UL file. UL publishes on an annual basis a directory of Recognized Components that for all PWB fabricators contains a general summary of recognized design and end-use parameters as well as the authorized symbols for identification of recognition.

UL will not divulge any additional information to anyone other than the individual designated by Digital as the *applicant* for Digital's PWB UL file. The *applicant* is the only individual who can formally approach UL for addition, change, or deletion of information in the UL file.

As of the date of this document, the *applicant* for Digital's UL file is:

Name: Gerald Gagnon
Loc: LJO1/B2
DTN: 226-2037
ENET NODE: BOARDS::GAGNON

The *applicant* can supply information (beyond that published in the UL Recognized Component Directory) concerning Digital's UL file to qualified Digital employees only.

In addition to the administration of Digital's UL file the *applicant* is responsible for defining and overseeing the appropriate course of action taken as a result of identified noncompliances to product safety requirements.

It is a requirement that each internal PWB manufacturing location have within their organizational structure a *plant specific* product safety individual. This individual is supplied with a sufficient level of UL file information to ascertain whether present or future recognized design, end-use, manufacturing process, materials, and markings are in compliance with product safety requirements at the local level. This individual is responsible for the identification and timely communication of noncompliance to the *applicant*. This individual is also responsible for carrying out the appropriate course of action defined by the *applicant* in response to any identified noncompliance at the local plant level.

In addition, this individual is responsible to act as the local interface with UL Follow-Up Service auditors who periodically audit each PWB manufacturing site for ongoing compliance. After each UL Follow-Up Service audit, this individual is responsible for submitting copies of audit paperwork as well as any variation notices identified by the UL auditor to the *applicant*.

In addition to the general responsibilities defined in the text under subhead 1.3 of this document, all pertinent groups are specifically responsible for communicating all present or future PWB design or end-use, manufacturing process, materials, and markings changes to the plant product safety individual (and *applicant* if necessary) for a determination of compliance.

2.2 PRODUCT SAFETY REQUIREMENTS—EXTERNALLY FABRICATED PWBs

For externally fabricated PWBs, Digital's UL recognition is maintained through the use of UL recognized PWB suppliers. It is preferable that printed-wiring boards supplied to Digital by external suppliers meet or exceed the same UL recognition parameters as Digital's internally fabricated PWBs. However, it is an absolute requirement that all external PWB suppliers be UL recognized to produce the specific PWB products that are being sourced. The external supplier shall notify Digital whenever the UL recognition of Digital sourced parts violates the recognized design pattern limits, recognized process, recognized laminate/prepreg/soldermask materials, and flammability rating of the external supplier. In addition, the external supplier shall notify all Digital purchasing entities within 24 hours of failure to meet any UL follow-up services testing. External suppliers shall furnish Digital purchasing with UL yellow card(s), latest printing, and UL test record pertinent to the product(s) being sourced.

2.2.1 Product Design and End-Use Requirements

Product design and end-use requirements are defined by Digital Equipment Corporation product-specific documentation and applicable Digital standards.

The external supplier must be aware of how these requirements compare with its own UL recognition limits and shall inform all Digital purchasing entities affected within 24 hours in the event of any actual or potential noncompliance that could adversely impact Digital or the supplier's ability to service Digital.

2.2.2 PWB Process Requirements

Unless specified otherwise in Digital product-specific documentation or other Digital standards, the processes by which an external PWB supplier fabricates Digital PWBs is generally not specified. The external supplier must be aware of how the processes used to produce Digital PWBs compare with its own UL recognized process limits as well as other regulatory agency requirements and shall inform the Digital purchasing entity within 24 hours in the event of any actual or potential non-compliance that could adversely impact Digital or the supplier's ability to service Digital.

2.2.3 PWB Material Requirements

The external supplier must be aware of how the material grades, vendors, and thicknesses used to fabricate Digital PWBs compare with its own UL recognized materials and shall inform the Digital purchasing entity within 24 hours in the event of any actual or potential noncompliance that could adversely impact Digital or the supplier's ability to service Digital.

2.2.4 Product Safety Markings

UL recognized marking requirements are the same for all PWB suppliers. The text under subhead 2.1.4 of this document describes those requirements. Consistent with UL and Digital product safety requirements, the product safety markings for all Digital PWBs are to be contained within the appropriate product safety frame blocks supplied with each Digital PWB design. External suppliers shall place their versions of the UL recognition markings exactly as they appear in the UL recognized component directory within block 2 per text under subhead 2.1.4 of this document.

Exceptions: Refer to the text under subhead 2.1.4 of this document.

2.2.5 Specific Responsibilities

All Digital purchasing entities are responsible for an understanding of the requirements of this document and for assuring that all externally supplied PWBs are in compliance. Compliance is assured when external suppliers are sourced with the PWB designs that they are formally recognized by UL (and other regulatory agencies where applicable) to produce.

All external suppliers must have individuals within their organizations that are responsible for monitoring and maintaining UL recognition (and other regulatory agencies where applicable). These individuals must be knowledgeable and capable of identifying any actual or potential noncompliance with the requirements of this document and shall inform the Digital purchasing entity and the Digital UL *applicant* if necessary within 24 hours.

APPENDIX A FLAMMABILITY TESTING

To guarantee the validity of internal/external simulations of flammability tests performed to UL 796 Standard for Safety—Printed-Wiring Boards and UL 94 Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, all samples for flammability testing shall be:

1. Subjected to the same PWB production operations defined in the UL process descriptions as the printed-wiring boards they represent. The only exception is that all copper must be removed from all layers.
2. Dimensions are 5.00 ± 0.02 inch (127.0 ± 0.51 mm) long × 0.50 ± 0.02 inch (12.7 ± 0.51 mm) × minimum laminate material thickness +0.000/– 0.002 inch (+0.000/ 0.051 mm) thickness as laminated.
3. Samples are to have all edges polished and corners radiused not to exceed 0.050 inch (1.27 mm).
4. Sample quantities are as follows:
   Bare laminate: 10
   Soldermask coated both sides: 10
5. Soldermask shall be applied and cured according to soldermask manufacturer's recommended processing.
6. All samples shall be conditioned at 121°C (250°F) for 1.5 hours, cooled in a dessicator, and thermally shocked to Digital assembly soldering conditions at the PWB fabrication site. The appropriate assembly soldering conditions are as specified in Figure 1 of this document.
7. Upon completion, samples shall be considered as prepared for flame testing.

Flammability Test:

Regardless of the testing site, the flammability test procedure and recording of all pertinent data is as follows:

1. All samples shall be conditioned for 48 hours at 23°C ± 2°C (73°F) and 50% ± 5% relative humidity.
2. Five bare laminate and five soldermask-coated samples shall be tested as described in UL 94 subheads 3.6 through 3.15: Vertical Burning Test for Classifying Materials 94V-0, 94V-1, or 94V-2.
3. During the test, the following information shall be noted and recorded on the Flammability Test Data Sheet that is attached:
   - Duration of flaming combustion after the first flame application
   - Duration of flaming combustion after the second flame application
   - Duration of glowing combustion after the second flame application
   - Whether or not samples burn up to the holding clamp

- Whether or not samples drip flaming particles that ignite the cotton

4. From the recorded data, materials can be classified as 94V-1 if:
   - No samples burn with flaming or glowing combustion up to the holding clamp.
   - No samples drip flaming particles that ignite dry absorbent surgical cotton located 12 inches (300 mm) below the sample.
   - No samples burn with flaming combustion for more than 30 seconds after either application of the test flame.
   - No samples burn with glowing combustion for more than 60 seconds after the second removal of the test flame.
   - The total flaming combustion time for the 10 flame applications (5 samples with 2 flame applications) shall not exceed 250 seconds.
5. If any one sample from the set of five samples fails to comply with the above requirements, another set of five samples shall be tested.
6. All retest samples must comply with the above requirements or the test is deemed a failure.

VERTICAL FLAME TEST DATA TO CLASSIFY MATERIAL PER UL 94 RATING, 94V–1

DATE OF TEST: _____
BASE MATERIAL: _____
THICKNESS: _____
SOLDERMASK: _____

TEST DATA FOR UNCOATED SAMPLES:

SAMPLE NUMBER	FLAMING INITIAL FLAME (SECS.)	COMBUSTION SECOND FLAME (SECS.)	GLOWING SECOND FLAME (SECS.)	TOTAL FLAME (SECS.)	TOTAL GLOW (SECS.)	BURN TO CLAMP Y/N	DRIPS Y/N
1							
2							
3							
4							
5							

GRAND TOTAL: FLAMMABILITY RATING:

TEST DATA FOR SOLDERMASK COATED SAMPLES:

SAMPLE NUMBER	FLAMING INITIAL FLAME (SECS.)	COMBUSTION SECOND FLAME (SECS.)	GLOWING SECOND FLAME (SECS.)	TOTAL FLAME (SECS.)	TOTAL GLOW (SECS.)	BURN TO CLAMP Y/N	DRIPS Y/N
1							
2							
3							
4							
5							

GRAND TOTAL: FLAMMABILITY RATING:

APPENDIX B REFERENCED DOCUMENTS

B.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00119-00	*DEC STD 119-0 Digital Product Safety - Introduction and General Requirements*
EL-SM176-00	*Printed-Wiring Board Manual*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

B.2 Other Documents

Document Number	Document Title
UL 796	*Standard for Safety—Printed-Wiring Boards*
UL 94	*Standard Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

B.3 Ordering Information

Following are the sources for documents not available from Standards and Methods Control.

- Underwriters Laboratories (UL), Publications Stock,
  33 Pfingsten Road, Northbrook, IL 60062,
  Telephone (312) 272-8800, X2612 or X2622

APPENDIX C RELATED DOCUMENTS

C.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-00176-00	*DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

```
+---------------------------------------------------------------------+
|                          READER COMMENTS                            |
|                                                                     |
| Your  comments  and suggestions  will help  Standards and Methods   |
| Control improve their services and documents.                       |
+---------------------------------------------------------------------+
```

Did you request this document? _____ If so, did it arrive within a satisfactory period of time? _____ Please comment.

What are your impressions of this document? Consider format, organization, completeness, readability, and illustrations.

————————————**FOLD ON THIS LINE**———————————————————————— -

Did you find technical or clerical errors in this document? If so, please specify the page number(s) and the error(s).

Are the instructions for the update package clear? _____
Was an index available? _____ If not, is one needed? _____
Do you have other suggestions for improving this document?

The following information is optional:

Name _____ Mailstop _____

Department _____ Node _____

Send your comments to JOKUR::PROJECTS, or fold, staple, and send this page through interoffice mail to:

```
+------------------------------+
|       READERS' COMMENTS      |
| STANDARDS AND METHODS CONTROL |
|           NRO4/D4            |
+------------------------------+
```